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A PRIMER ON DENTAL RADIOLOGY

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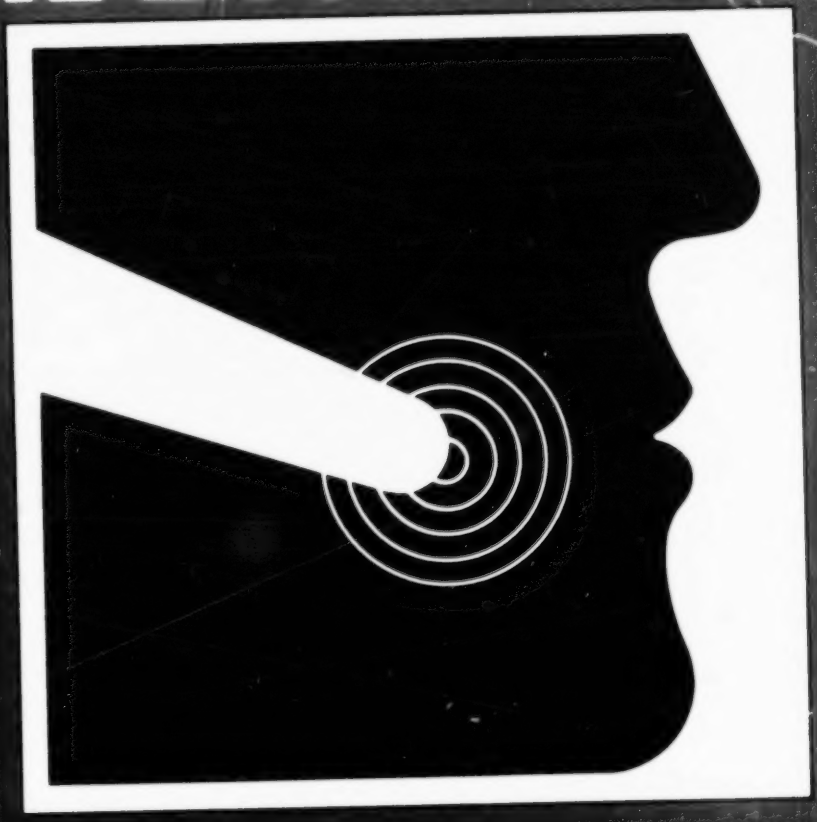

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National Center for Health Care
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PREFACE

Medical technologies pose many complex and interrelated issues— for the health care professions, for patients, and for society. To help address these considerations, Congress established the National Center for Health Care Technology (NCHCT) to conduct and sponsor assessments of health care technologies. Public Law 95-623 (the Health Services Research, Health Statistics, and Health Care Technology Act of 1978), which created the Center, defines health care technology broadly to include any means to prevent, diagnose, or treat disease or promote health. Furthermore, it calls for evaluation not only for safety and efficacy, but also for the social, ethical, and economic implications of technologies.

One of the basic operating guidelines for the National Center for Health Care Technology is that the assessment of any technology should be conducted in an open atmosphere with the opportunity for all interested parties to participate fully. The Center recognizes that for full participation to occur, the non-medical participants must have the opportunity to become informed about the clinical and scientific aspects of the particular technology.

This booklet "A Primer on Dental Radiology" was prepared by the Center Staff with major contributions from Robert Goepp, DDS, of the Zoller Clinic, University of Chicago, Lirka Joseph, DrPH and Harvey Rudolph, PhD, of the Bureau of Radiological Health, Food and Drug Administration.

We hope this Primer will prove useful to participants in the Technology Assessment Forum. In addition, it is offered to professional and patient education programs for use in their various endeavors.

Seymour Perry, MD
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Care Technology

A PRIMER ON
DIAGNOSTIC DENTAL RADIOLOGY

Radiology is used extensively in diagnosing dental disease. In the United States, approximately 145,000 dental X-ray machines are in operation, and about 102,620,000 individuals made 335,702,000 dental visits in 1976. In 1978, 82 percent of dental patients received radiologic services. Total 1978 expenditures for dental care amounted to $10 billion, $730 million of which was for dental radiologic services.[1] Public concern about radiation exposure and health care costs is increasing. The purpose of this Technology Assessment Forum is to determine and promote the most effective, safe, and efficient uses of dental radiology.

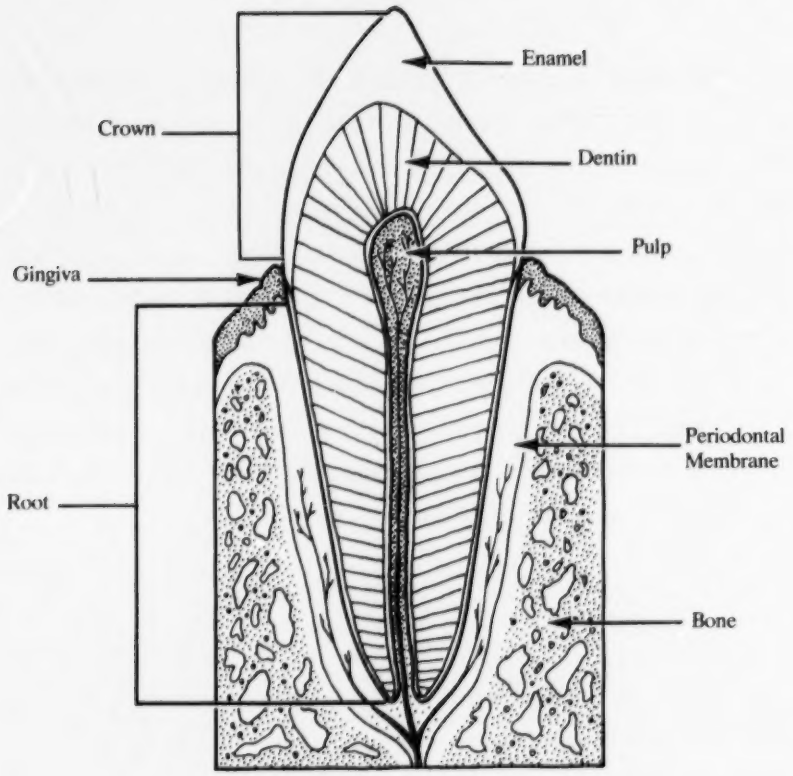
Enamel
Crown
Dentin
Pulp
Gingiva
Periodontal
Membrane
Root
Bone
TOOTH CROSS SECTION

Figure 1

DENTAL DISEASES

Of the many forms of dental disease, the most common are dental caries and periodontal disease. Clinical examination can identify both of these conditions, but the earliest stages can be detected only by radiographic examination. Radiographic examination also assists in diagnosing other diseases of the mouth and gums.

Dental caries (tooth decay) is a bacterial process that involves only the tooth itself and results in the formation of a cavity. A number of interrelated factors such as bacteria, a food source (carbohydrates or sugar from one's diet), and a susceptible tooth contribute to this disease. Dental caries proceeds at varying rates because of the nature of the different tooth tissues. Decay progresses slowly in the enamel, which is the hard, mineralized substance covering the crown of the tooth **(Figure 1)**. It proceeds more rapidly in the dentin, which is the softer layer immediately underneath. Once decay reaches the dentin, immediate treatment by the dentist is necessary to prevent the disease from reaching the tooth pulp (the chamber containing the tooth's nerves and blood supply) and possibly causing an abscess to form or the tooth to be lost. Dental caries is the main reason for tooth loss in individuals under the age of 35.

Periodontal disease is a condition of the tooth support structures, including the bones of the mouth, the gums, and

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the tooth ligaments. Ultimately, it can destroy those structures that hold the teeth securely in the mouth. The disease has two phases, gingivitis and periodontitis. Gingivitis affects only the gum tissues. When the disease progresses to involve and possibly destroy the supporting tissues, such as the periodontal membrane and it is termed periodontitis. Periodontal disease is not the result of a single agent, but dental plaque and calculus (tartar) seem to be contributing factors. Tooth loss occurring over the age of 35 is generally a result of periodontal disease.

The practice of dentistry also includes radiologic examination of facial bones and soft tissues for the diagnosis and treatment of tooth disease extending into the jaws, trauma to facial bones, and guidance of growth and development of teeth and facial bones

Figure 2

DIAGNOSTIC DENTAL RADIOGRAPHS

Several types of radiographic examinations assist in the diagnosis of dental disease. The full mouth X-ray examination, a combination of 14 to 17 periapical and 2 to 4 bitewing films, is used mainly as a means of initially evaluating the current dental condition of a new patient. The periapical film shows the entire tooth stucture, both crown and root, and the supporting bone **(Figure 2)**. It is most frequently used to examine the entire tooth and bony structures. A bitewing shows several teeth in a closed bite relationship in the back of the mouth **(Figure 3)**. The bitewing is used to examine the interproximal areas (the parts of the teeth in contact with each other) and the patient's periodontal state.

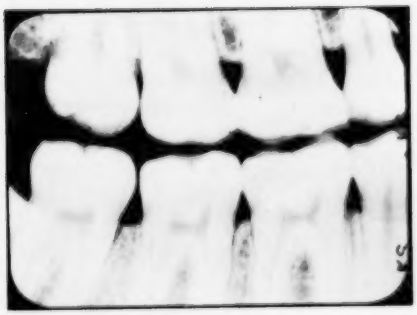

Figure 3

Other types of radiographs are also sometimes used, in particular:

- The Panoramic Radiograph - a single film showing both the maxilla (upper jaw) and the mandible (lower jaw). It is one of many diagnostic aides used to evaluate the growth and development of the teeth and jaws, and to assess abnormal conditions of the teeth, bony structures, and soft tissues **(Figure 4).**

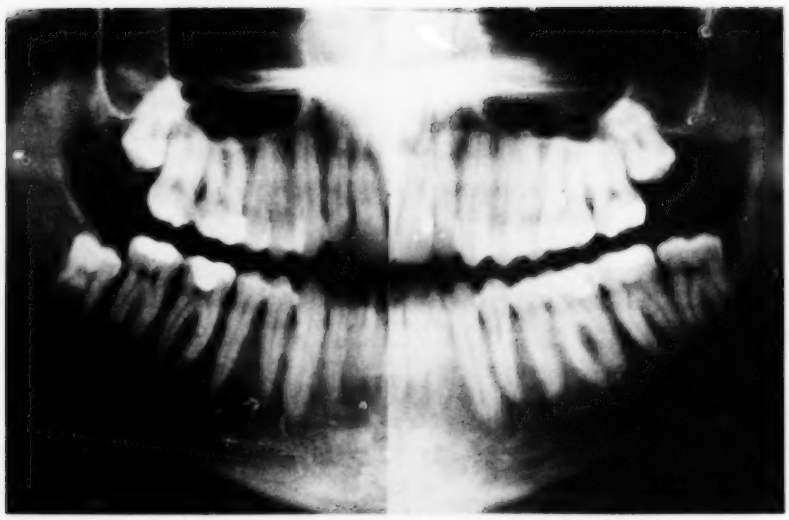

Figure 4

- The Cephalometric Radiograph - frequently used by orthodontists to make measurements so that growth and development of the skull and jaws can be evaluated. This radiograph usually shows the skull, jaws, and teeth from a profile view **(Figure 5).**

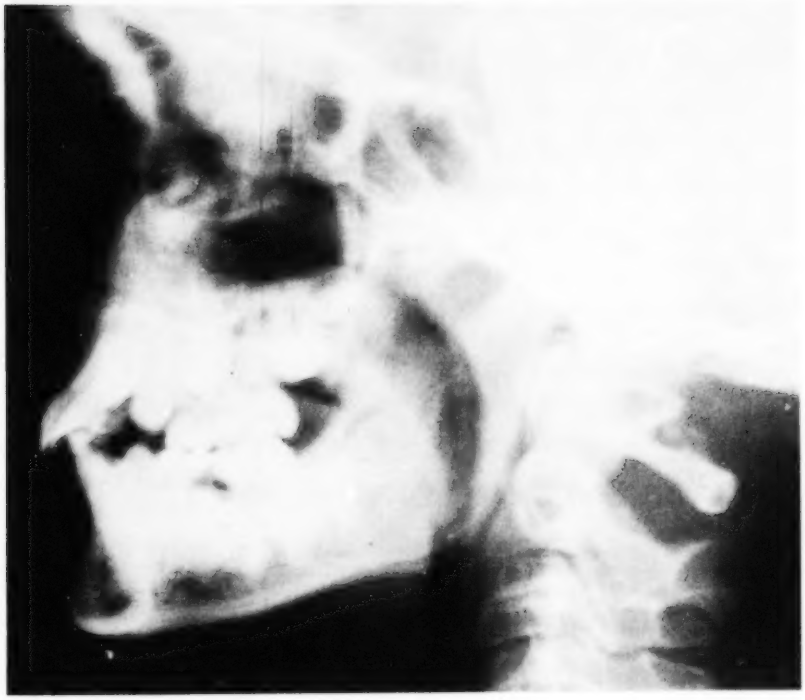

Figure 5

ISSUES IN DENTAL RADIOLOGY

Equipment

Modern conventional dental units employ an open-ended position-indicating device (cylinder) used primarily for aiming the tube head before making an X-ray exposure. Commonly 4 to 16 inches in length, the cylinder is designed to insure that an appropriate distance between the X-ray source and the patient's skin is maintained during the exposure. Many newer position-indicating devices also help reduce scatter radiation by incorporating a cylindrical metal collimator within the plastic cylinder.

Radiographic films are of two basic types: screen and direct exposure. Direct exposure films are exposed directly to the X-rays. Screen films are exposed primarily by the fluorescent light given off by intensifying screens following absorption of X-rays. Radiographic films can also be classified as intraoral (within the mouth) and extraoral (outside the mouth), according to their placement during use. Intraoral projections usually employ direct exposure film, whereas extraoral projections generally use screen film.

Newer technologies in dental radiology include:

- Panoramic X-ray examinations (mentioned above), in which both the X-ray tube and the radiographic film move about the patient's head on two or more com-

mon centers of rotation to produce a view of a curved plane through the dental arches;

- The intraoral source X-ray machine, which employs a miniature X-ray tube positioned inside the mouth to expose a film mounted extraorally;
- Intraoral xeroradiography, in which dental images are produced by using the principles of xerographic copying.

Radiation Risks

Even at the relatively low levels of exposure produced by dental examinations, radiation may pose a small risk of biologic harm. Reduction of risk depends on reducing unnecessary radiation exposure by decreasing the frequency of exposure, the amount of radiation energy per exposure, or both.

In general, no short-term biologic effect can be detected following exposure from diagnostic dental radiology. However, over longer periods of time, exposures not much larger than those sometimes used in dentistry have produced biologic effects in humans and experimental animals. The most important of the currently recognized delayed effects is the induction of cancer.

The estimated average equivalent whole-body per-person exposure to the U.S. population from dental radiography is

about 7 mR per year.[2] It has been projected that this exposure could lead, at most, to an additional 8 to 11 deaths from leukemia per year in the U.S. population. The risk of developing any type of cancer within 25 years of irradiation as a result of a full-mouth examination consisting of 21 films has been estimated to be 3 in 1 million or 0.0003 percent per exam.[3]

Training

The competency of the individual who orders or performs a dental X-ray examination is an important determinant of the general quality of radiographic services. Training and curriculum requirements, as they apply to the use of ionizing radiation, vary according to category of personnel.

Dentists receive four years of training following college. Radiological curricula vary among American dental schools. The American Association of Dental Schools recently published a position paper on the teaching of dental radiology [4].

Dental hygienists are required to have two years of formal training from one of the 182 schools of dental hygiene accredited by the American Dental Association, and are required to take the Dental Hygiene National Board examination before practicing dental hygiene. In general, courses that a dental hygienist takes are more intensive than those in a one- or two-year training program for dental assistants. In radiology, however, the courses are in many cases identical. Both the hygienist and the assistant spend

approximately the same number of class hours in radiology courses.

An ADA-certified dental assistant must have one or two years of academic training (depending on the institution) from one of the 280 (as of 1973) accredited dental assistant programs in the United States.[5] The curriculum in a dental assisting program includes courses in radiation physics, radiation biology, radiation techniques, and, in a few cases, radiation safety. The number of hours devoted to dental radiology varies from 2 to as many as 64, depending on the school. In many cases, however, the dental assistant's training is on-the-job rather than formal. In most states, the assistant is not required to take any certifying examination before taking dental X-rays. However, some states prohibit assistants from taking X-rays.

Other Issues

Other issues related to dental radiology are:

- Costs and possible overutilization of, as well as trends in, dental radiologic examination;
- Federal and State regulatory and legislative activities pertaining to quality control in dental radiology;
- The impact of new trends in financing dental care on issues of dental radiology; and
- Priorities in research to advance the state of diagnostic dental radiology.

CONFERENCE TERMS:

Some other terms that will be used at the conference are defined as follows:

- Administrative radiographs are radiographs used for other than diagnostic purposes. For example, they may be employed to provide evidence that a specified treatment has been given or to meet a requirement in an academic program.

- High-yield criteria are guidelines to assist the practitioner in identifying those patients who are likely to have positive radiographic findings. This approach to diagnostic radiology has been studied and used in some areas of medical practice. The purpose is to reduce the number of unproductive radiographic examinations.

- A quality assurance (or quality control) program identifies problems in exposure and processing so that appropriate modifications can be made. Such a program attempts to eliminate exposure to radiation by reducing the dosage, the number of retakes, and the number of over-exposed radiographs.

- Exposure is the amount of ionization produced in a volume of air by an X-radiation beam. It is measured in roentgens (R) and milliroentgens (mR).

- Dose is the amount of radiation energy absorbed by a substance at a particular point. It is measured in Rads.

- Somatic effects from radiation exposure directly affect the person irradiated, whereas Genetic or hereditary effects are expressed in the future offspring.

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